Solar Plant Supervisory System
User Manual

rev 1.19

Robotina d.o.o., OIC-Hrpelje 38, SI-6264 Kozina, Slovenia, phone +386 5 689 2020, fax +386 5 689 2039, www.robotina.si, info@robotina.si

Table of contents

Table of contents 2
Warnings 3
1. Overview 4
2. Order Code 5
  2.1. Standard equipment 5
  2.2. Optional equipment 6
  2.3. Software 6
  2.4. Tools 7
  2.5. Spare parts 7
3. Devices 8
  3.1. String Monitor Box 8
  3.2. String Diode Box 9
  3.3. DC Combiner Box 9
  3.4. Power Supply Unit 10
  3.5. Solar Controller Unit 10
4. Connecting 11
5. Commissioning 15
  5.1. Prerequisites 15
  5.2. Regular operation 15
  5.3. Troubleshooting 17
  5.4. String monitor procedures 19
  5.5. Solar controller procedures 21
6. Maintenance 25
7. Technical Data 26
  7.1. String Monitor Box 26
  7.2. String Diode Box 27
  7.3. DC Combiner Box 28
  7.4. Solar Controller Unit 29
  7.5. Power Supply Unit 30
8. Appendix 31
  8.1. Available signals 31
  8.2. Status tree 35
  8.3. Touch panel screens 37

Warnings

This manual contains important instructions for the Solar Plant Supervisory Sistem that must be followed during installation and maintenance procedures. Read carefully and keep for future reference.

Warning: Hazardous voltage is present on the product when the system is operating.

Warning: Contains components that may become hot during normal operation.

Warning: Only trained and qualified personnel should be allowed to install, replace, or service this equipment.

Warning: No connections or disconnections are to be made during operation. Turn disconnector switch off before any installation and maintenance procedures.

Warning: This product can only function correctly if it is transported, stored, set up and installed correctly, and operated and maintained as recommended. Failure to comply with applicable codes and standards can result in damage to equipment or serious injury to personnel.

Warning: To minimize the risk of safety problems, follow all applicable local and national codes that regulate installation and operation of your equipment. These codes vary geographically and may change with time, it is your responsibility to determine which codes should be followed, and to verify that the equipment, installation, and operation comply with the latest revision of codes.

Caution: We do not guarantee the product described in this manual is suitable for your application, nor do we assume any responsibility for your product design, installation or operation.

Caution: Take care not to damage the terminals by using inappropriate tools or wires.

Caution: Sensitive electronics inside can be destroyed when touched electrostatically charged. Discharge via earth potential before touching and wear appropriate protective gear.

Warning: Disposal of this product should be handled according to national laws and regulations.

Copyright © 2010 Robotina d.o.o. All rights reserved. No part of this document may be reproduced without written consent from the owner. All information is subject to change without prior notice.

1. Overview

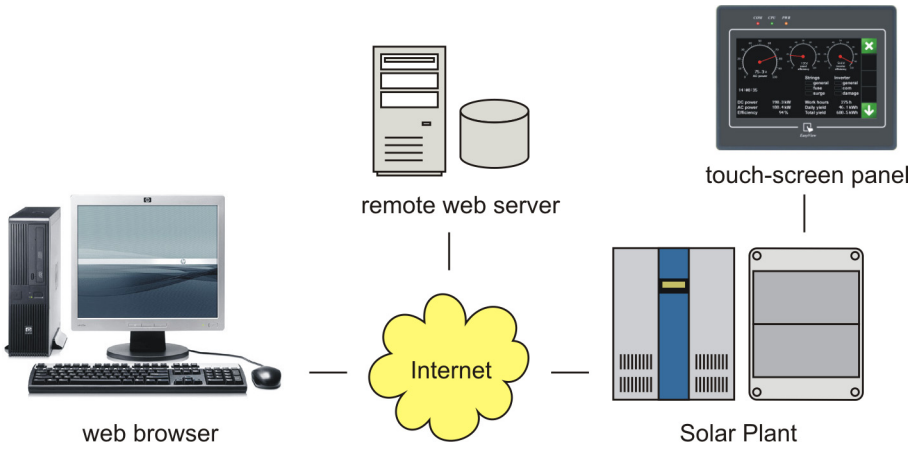
SPSS is a complete solution for monitoring solar power plants. It offers measurement, status and summary data, locally or remotely.

Comparing to a non-monitored system, SPSS provides faster error detection and better troubleshooting, resulting in bigger and more predictable yield. Early warning sub-system may show error before damage is made, ensuring energy production approach the theoretical maximum. Anti-theft protection is included in the basic system.

SPSS consists of:

- String Monitor Box..... SMB
- String Diode Box ..... SDB
- DC Combiner Box ..... DCB
- Power Supply Unit..... PSU
- Solar Controller Unit ..... SCU

String Monitor measures currents, monitor fuses, surge protectors, voltage and temperature, and sends all data to solar controler. Update rate is cca. 2 seconds. Positive and negative currents are measured separately and compared, to detect a possible leakage.



System is accessable locally (touch panel and Solar Mini software), and remotely (Solar Web software installed on a PC server). Both recent measurements and stored dbase data are available. If Internet connection is not available, options are GPRS or radio modem.

A variety of optional equipment exist, like weather station or camera. Standard industrial i/o modules (0..10V, 4..20mA) are also available. SPSS is fully open and programmable, giving system integrators possibility to incorporate their own solutions.

Inverter is integrated in the system, so all measurements and statuses, as well as history data, are available through touch panel and Internet.

For inverter instalation and maintenance, check manufacturer documentation.

2. Order Code

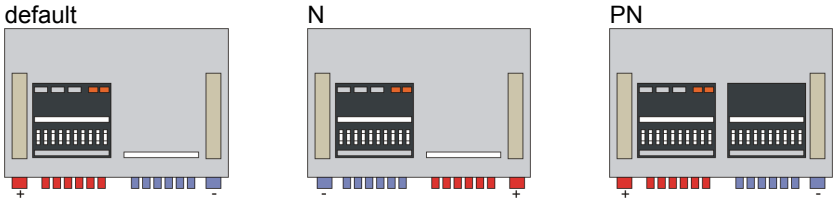
2.1. Standard equipment

SMB-10-x-x-x-x-x-x (String Monitor Box), where x may be empty (default) or one of the following options:

- plastic housing with transparent lid (default)
- stainless steel housing (option S)

- 10 strings, 10 fuses (positive only, common minus), 10 measurements, earthed or galvanically isolated (default)
- 10 strings, 10 fuses (negative only, common plus), 10 measurements, earthed or galvanically isolated (option N)
- 10 strings, 10+10 fuses (plus and minus), 10+10 measurements, earthed or galvanically isolated (option PN)

default N PN



- cage-clamp wire terminals and cable glands (10 strings, default)
- faston terminals and cable glands (10 strings, option F)
- faston terminals and cable glands, two strings in parallel (20 strings, option Fx2)
- Multi-Contact Solarline MC3 (PV-ADSP3/BP3) connectors (10 strings, option MC3)
- Multi-Contact Solarline MC3 (PV-ADSP3/BP3) connectors, two strings in parallel (20 strings, option MC3x2)
- Multi-Contact Solarline MC4 (PV-ADSP4/BP4) connectors (10 strings, option MC4)
- Multi-Contact Solarline MC4 (PV-ADSP4/BP4) connectors, two strings in parallel (20 strings, option MC4x2)
- custom connector options available

- fuse 6-16A, 1.5*Isc (as specified by panel maker, option F6, F8, F10, F12 or F16, required, no default value)

- no disconnector (default)
- with disconnector switch (option D)
- with disconnector switch and auxiliary contact (option DA)

- side mounting ears, 4x10mm screws (default)
- pole mounting bracket (option POLE)
- custom mounting options available

Example: SMB-10-MC4-F16-D (monitor box in plastic housing with transparent lid, MC4 connectors for 10 strings, 16A fuses and disconnector switch).

SDB-10-x (String Diode Box), where x may be one of the following options:

- faston terminals and cable glands (10 strings, option F)
- Multi-Contact Solarline MC3 (PV-ADSP3/BP3) connectors (10 strings, option MC3)
- Multi-Contact Solarline MC4 (PV-ADSP4/BP4) connectors (10 strings, option MC4)
- custom connector options available

DCB-x-x (DC Combiner Box), where x may be one of the following options:

- number of inputs (2-20, required, no default value)
- fuse (option F32, F40, F63, F80, F100, F125 or F160, required, no default value)

Example: DCB-12-F100 (DC combiner box with 12 inputs (for 12 SMBs), and 24 fuses (plus and minus), 100A each).

SCU-20-x-x (Solar Controller Unit), where x may be empty (default) or the following option:

- GSM/GPRS modem, Internet connection and SMS access (option GSM1)
- Modbus-TCP interface, slave, used to connect to devices from other manufacturers (option MB)

PSU-20 (power supply unit for up to 20 string monitors, including CAN opto-isolation)

No options, only one version is available.

2.2. Optional equipment

COM-PCS
Communication controller for Sanrex central inverter. Mounted inside inverter, compatible with 100/250/500kW inverters.

COM-xxx
Communication controller for inverters from other vendors. Depending on inverter, it provides access to measurements (read only), status (read/reset) and parameters (read/write). Hardware connection to inverter is RS232/485.

REF-CELL
Standard insolation reference measurement cell, 0..1000 (REF-CELL-1000) or 0..1400 (REF-CELL-1400) W/m^2, used to calculate PV efficiency. Extended range is suitable for tropic locations.

ES-A
External temperature sensor, measuring outdoor or panel temperature. 5m cable, connects to string monitor.

TS-H
Ambient temperature and humidity sensor for indoor use (inverter house), connects to CAN bus.

WEATHER-STATION
Module to gather meteorological data: wind, temperature, humidity, rain. Includes sensor (Vaisala WXT-520) and communication adapter (COM-WXT).

IP-CAMERA
Visual plant overview, displaying live video. Camera is selected according to application.

GSM-ROUTER
GSM/3G router, internet connection for multiple solar controllers and optional devices, e.g. IP camera.

RADIO-MODEM
Radio-modem connection, suitable device selected according to user requirements.

INFO-DISPLAY
Large (100x60cm) LED display, showing production, power and other data. Various sizes available on request.

2.3. Software

SOLAR-WEB-x (full-featured monitoring/control system), where x may be one of the following options:

- brand-name server, preinstalled and ready to use (hardware+software) (option HW)
- software ready to be installed by user (software only) (option SW)
- account on www.solar-cybro.com server (username/password only) (option AC)

Features:

- on-line monitoring measurements and status signals
- remote access and control using standard web browser
- hosted locally or remotely on commercial hosting service
- data-base storage for long-term access and analysis
- simple one-click data export to spreadsheet program
- immediate email notification in case of failure
- anti-theft alarm, access control and video surveillance

SOLAR-MINI
Quick plant overview, displaying live data. Provides a simple interface, preconfigured for the actual plant. Running on a Windows-based PC, in a local network. Small footprint allows running on lightweight Atom-based touch panels.

SOLAR-SCOPE
Set of software tools for quick error detection and plant comissioning.

OPC-SERVER
Communication driver which may provide connection to a monitoring system from other manufacturer.

CUSTOM-SCADA
Monitoring system made upon user requirements, based on Solar-Web, Iconics Genesis32 or other scada system.

2.4. Tools

Screwdriver WAGO type 3
- used to connect/disconnect SMB input terminals
- item no. 210-621 (5.5x0.8mm flat, partially isolated shaft)

Screwdriver WAGO type 2
- used to disconnect SMB communication and I/O terminals
- item no. 210-620 (3.5x0.5mm flat, partially isolated shaft)

Torque wrench M10
- torque 10..20Nm
- used to connect/disconnect SMB output terminals

Fuse puller, Cooper Bussman type FP-2
- isolated pliers for safe exchange of PV fuses

Service toolbox kit
- contains screwdrivers, torque wrench and fuse puller

NAD Manager
- electronic device for setting communication addresses
- may be used for commissioning and replacing faulty device
- 2m cable (RJ9/RJ9) included

2.5. Spare parts

String monitor box

- fuse 6, 8, 10, 12 or 16A
- surge protection plug-in replacement module
- pressure equilizing element (Goretex)
- transparent cover with seal

Power supply unit

- overvoltage protection

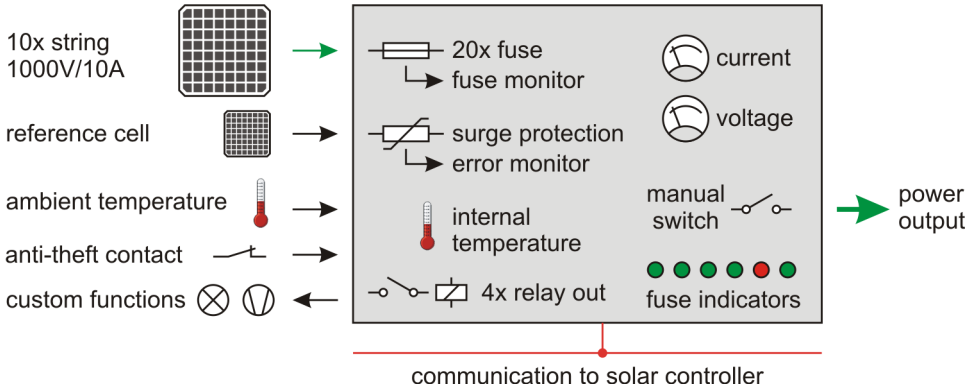
DC combiner box

- fuse 32, 40, 63, 80, 100, 125 or 160A

3. Devices

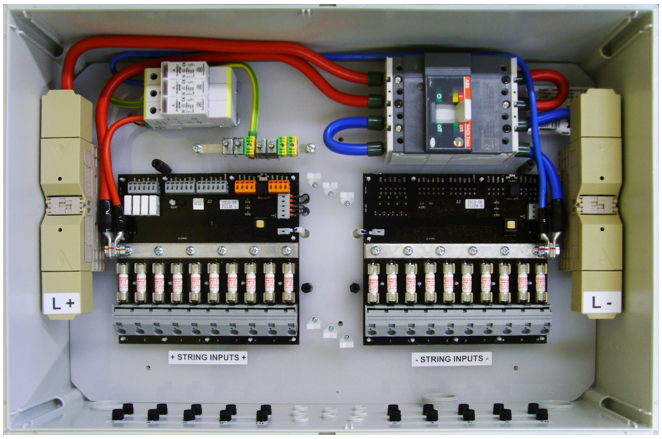
3.1. String Monitor Box

String Monitor measures currents, monitor fuses, surge protectors, voltage and temperature, and sends all data to solar controler.

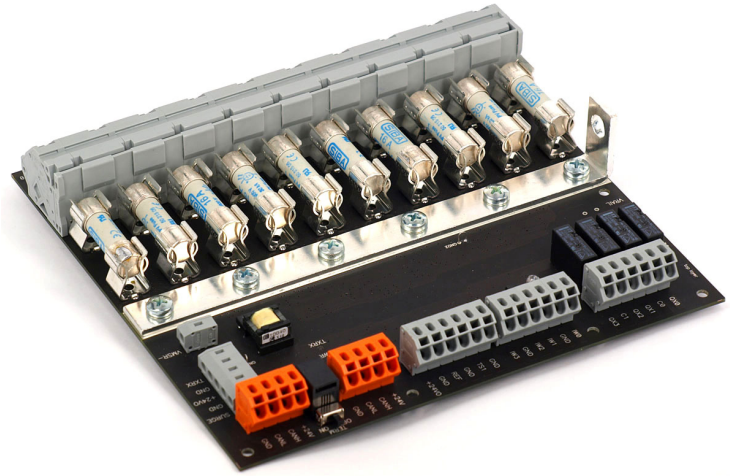


Both positive and negative legs are measured (option PN). If currents are not same, a current leak is reported. Update rate is cca. 2 seconds.

Picture shows insides of monitor box, plastic box version with disconnector switch.



Communication connectors (orange) are located on the back side. Custom input and output connectors are gray.



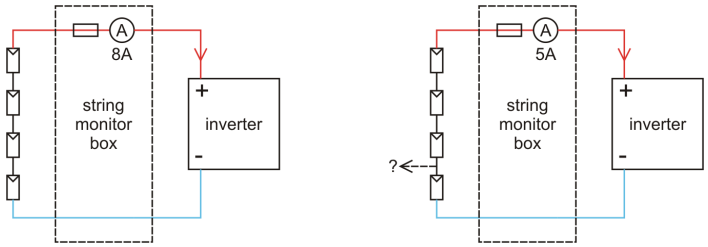
Termination should be on for last device in chain (position number 100). Other devices should have termination switch in off position.

Positive/negative current

Measuring both positive and negative currents ensures better failure detection.

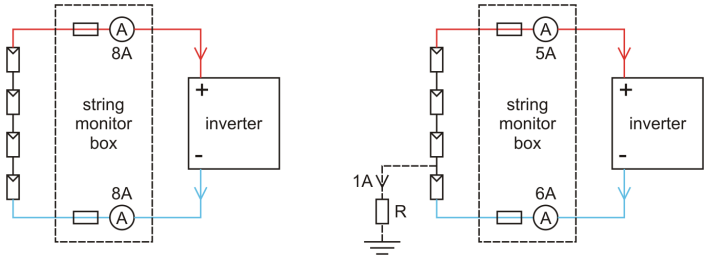
Example:

Assume grounded system with 8A nominal string current. Over time, output of string decreases to 5A.



Measuring only positive side, it is not possible to determine the failure. It may be caused by a number of different reasons: faulty panel, dirty panel, lousy connection, shortcut, corroded connector, bad measurement or other reasons.

In such case, failure detection relies on experienced and well-equiped technican ("check what's wrong").

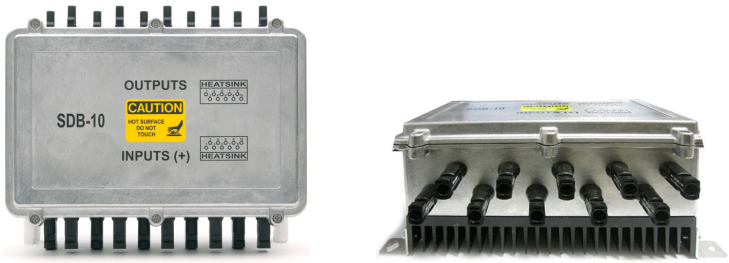


Measuring both sides, the failure is obvious - there is a partial shortcut, leaking 1A to ground. String power is cut to half.

Investigation is made remotely, and technican is send to perform a specific task ("shortcut to ground somewhere between 1st and 2rd panel").

3.2. String Diode Box

String Diode Box provides a serial diode for each string. Diodes protect strings against reverse current, which may occur when panels are shaded.



3.3. DC Combiner Box

DC Combiner Box is a passive combiner for power lines comming from string monitors, and going to inverter.

Each input has both positive and negative fuse, and disconnector switch.

3.4. Power Supply Unit

Power Supply Unit provides power supply for string monitors, opto-isolation, and surge protection.

Features:

- 100-240Vac input
- 24Vdc power supply output for string monitors
- overvoltage protection (string monitor side)
- CAN/CAN opto-isolation

PSU is mounted inside inverter house.

3.5. Solar Controller Unit

Solar Controler Unit combines status and measurements from string monitors and inverter (and other devices), calculates power, energy and averages, and store short-term data.

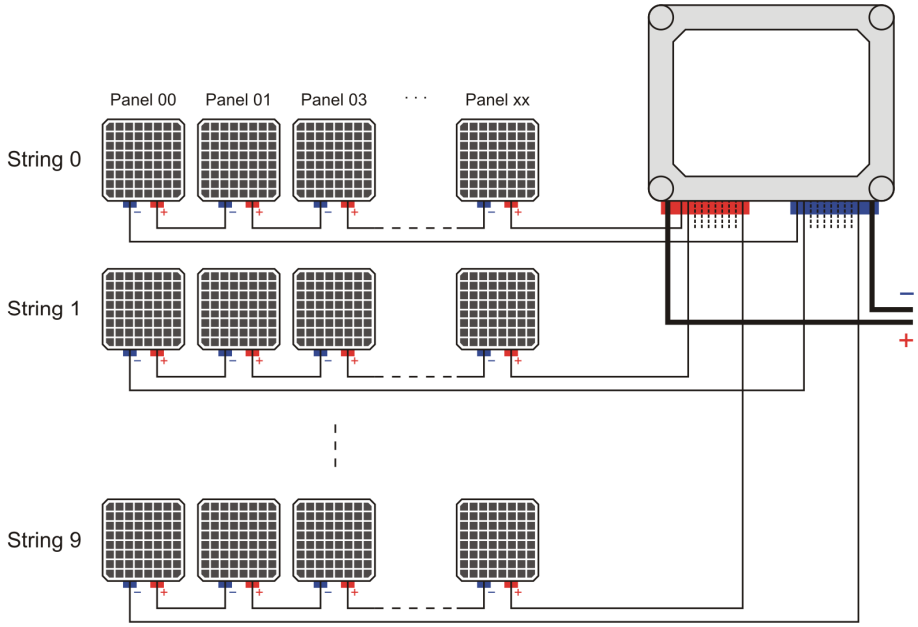
Features:

- touch-screen 4.3" color
- 100-240Vac input
- 24Vdc power supply output for expansion modules inside the inverter house
- Ethernet connector (RJ-45/UTP)

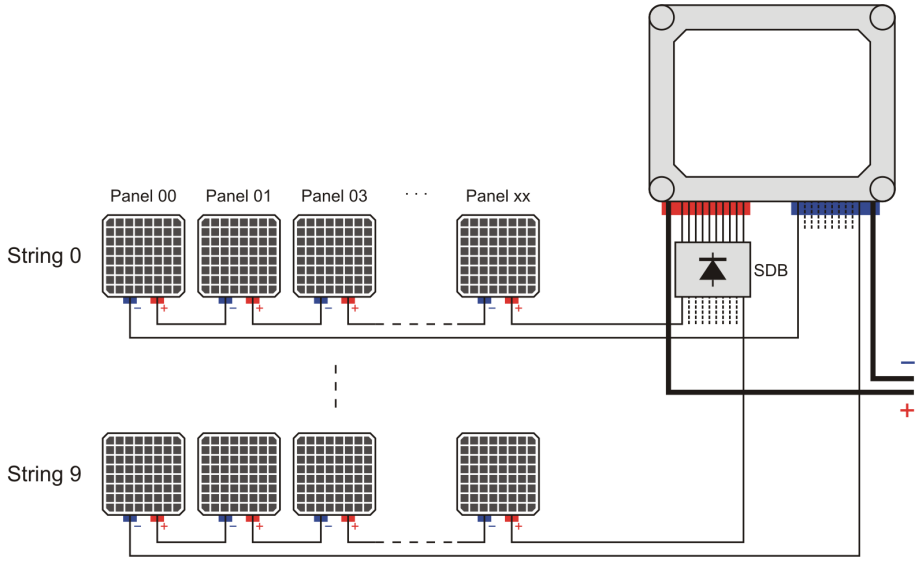
Touch-screen is used for setting parameters and monitoring.

4. Connecting

Connecting PV modules into strings, and connecting strings to string monitor:



Connecting PV modules into strings, and connecting strings to string monitor, with string diode box:



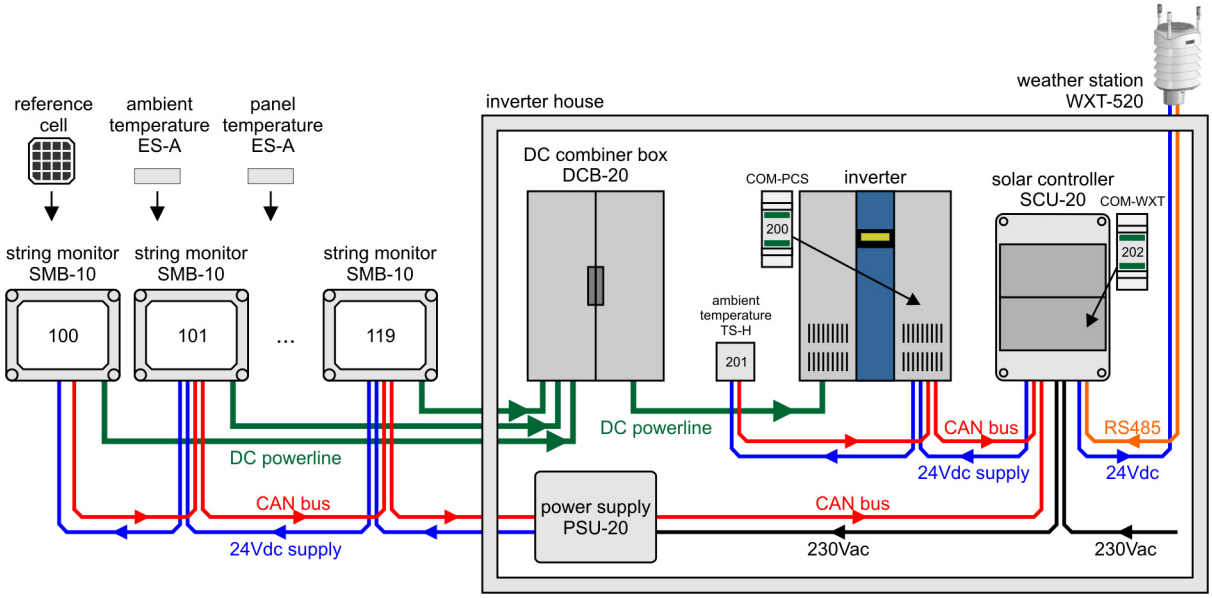
Each string monitor may have up to 10 strings connected. Actual number of strings may be less, or even different among string monitors. However, strings must be connected in order, first on input 1, second on input 2, third to input 3, etc.

The following example shows one possible way to connect 54 strings:

device	SMB	SMB	SMB	SMB	SMB	SMB
position number	100	101	102	103	104	105
connected strings	10	10	10	8	8	8

Solar controller automatically determines number of connected strings, there are no configuration parameters related.

Single-pole connection diagram:



Reference cell, ambient temperature and panel temperature sensors are connected to a nearest string monitor. Maximum cable length is 5 meters. Write down the actual position, it will be needed later.

Communication cable should be connected in line (not star) configuration, from PSU to last string monitor. Branching is not allowed. 24Vdc power cable should follow the same path.

Termination switch should be set to "on" position for last device in chain (position number 100). Other devices should have termination switch set to "off" position.

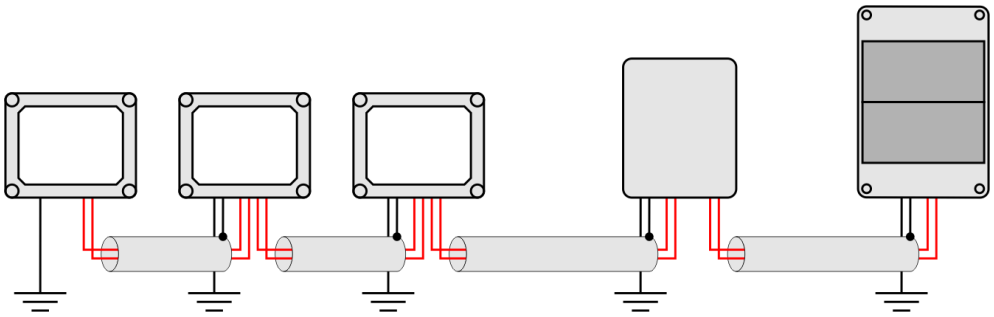
Wire gauge for 24Vdc supply:

	total length				
string monitors	100m	200m	300m	400m	500m
1 to 5	0.5mm^2	0.5mm^2	0.5mm^2	0.75mm^2	0.75mm^2
6 to 10	0.5mm^2	0.5mm^2	0.75mm^2	1.5mm^2	1.5mm^2
11 to 15	0.5mm^2	0.75mm^2	1.5mm^2	1.5mm^2	2.5mm^2
16 to 20	0.75mm^2	1.5mm^2	1.5mm^2	2.5mm^2	2.5mm^2

Wire gauge for CAN bus:

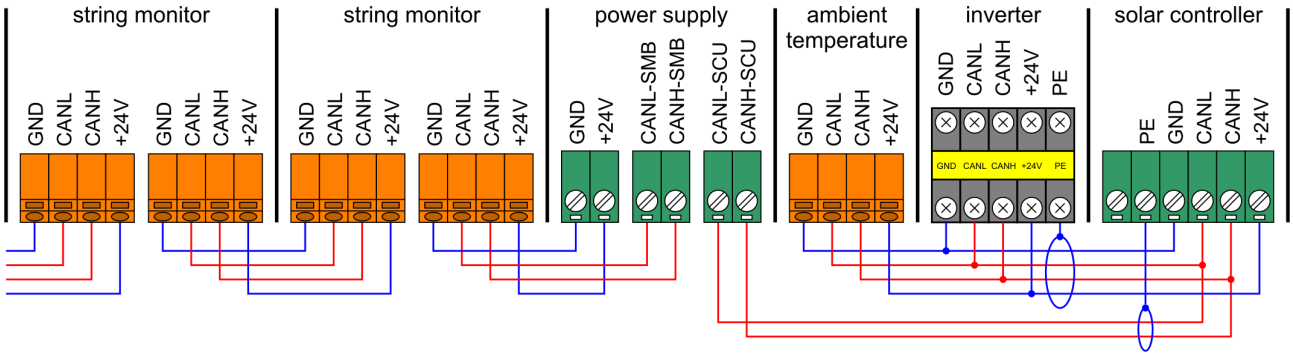
	total length				
	100m	200m	300m	400m	500m
baudrate	100kbps	100kbps	100kbps	50kbps	50kbps
wire gauge	2x0.25mm^2	2x0.25mm^2	2x0.5mm^2	2x0.5mm^2	2x0.5mm^2

CAN bus cable should be shielded, e.g. RE-Y(ST)Y 2x0.5mm^2. Shield is connected to ground for outgoing cable, and isolated for ingoing, i.e. each cable is grounded once, closer to solar controller.



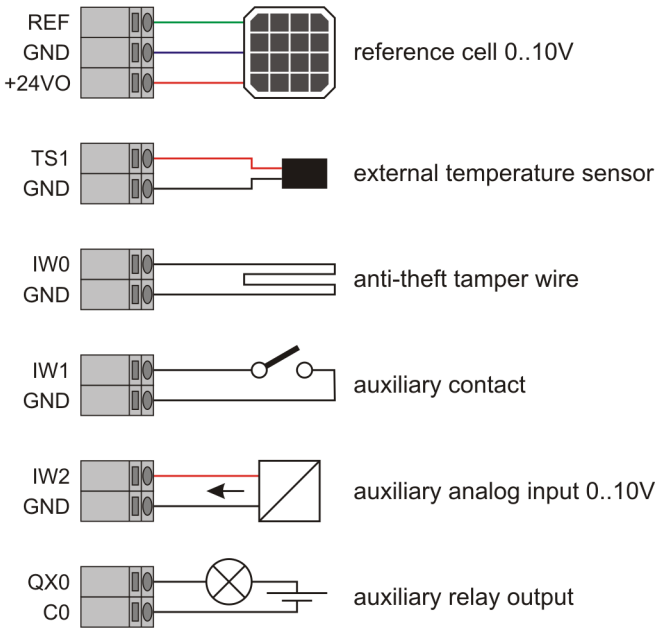
Grounding should be made according to local regulations. Ground wire should be at least 2.5mm^2.

Wiring diagram:



Optional equipment

According to user requests, various optional equipment may be connected:

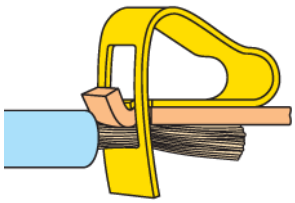


Cable shield for reference cell should be tied to ground rail. If external temperature sensor (ES-A) comes with shielded cable, it should not be connected.

Sensor TS-H should be properly oriented. Label "THIS SIDE UP" is visible when housing is open. If sensor is oriented in a wrong direction, measurement offset of about 10°C will be encoutered.

Wiring operation

PV input terminals (20mm pitch)

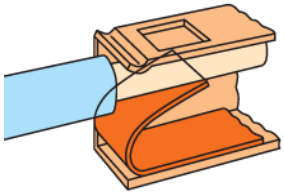


Strip off
Remove insulation 12-13mm.

Connect
Open clamp using screwdriver (WAGO type 3), and insert wire with no force.

Disconnect
Open clamp using screwdriver (WAGO type 3), and remove wire with no force.

Communication and I/O (5mm pitch)



Strip-off
Remove isulation 10-12mm.

Connect
Insert wire into cage clamp with moderate force. No tools needed.

Disconnect
Open clamp using screwdriver (WAGO type 2), and remove wire with no force.

We recommend to use stranded wire and ferrules.

5. Commissioning

Commisioning is a process of setting plant into operation. This chapter describe actions and measures needed to ensure flawless operation. Commissioning should be performed by a certified professional. Damage which may emerge because of improper handling is not covered by warranty.

5.1. Prerequisites

1. Mounting

Check whether devices are installed according to specifications. Devices should be attached firmly, wobbling is not acceptable. Front covers should be closed and properly sealed.

2. Wiring

Obtain report from company who made wiring. Check wiring against the specifications. Pay special attention to shielding, grounding and communication lines.

5.2. Regular operation

1. Serial numbers

Use a sheet of paper to write down serial numbers of connected devices. Serial number is printed on a label, attached to device. Pay a special attention to correct order. By a convention, first string monitor is one the on the far end of the line, opposite of solar controller. Do not start counting other way around.

device	SMB 1	SMB 2	...	SMB 20	COM-PCS	TS-H	COM-WXT
serial number	9817	9973	...	9912	9517	9914	9288

2. Termination switch

Open box cover (transparent lid) of the first device (far end of the cable), and set termination switch to "on". Close and secure cover. Check that all other termination switches are set to "off".

device	SMB 1	SMB 2	...	SMB 20	COM-PCS	TS-H	COM-WXT
termination switch	on	off	off	off	-	-	-

Termination resistor on the another side is set permanantly (inside power supply or solar controller).

If in doubt that switches are set correctly, use a multimeter to check resistance between CANL and CANH. Resistance should be about 60 ohms, or a little more when cables are very long or thin. If resistance is below 60 ohms, two or more termination switches are set to "on" position. If resistance is 120 ohms or more, no termination switch is "on". During the measurement, power supply must be off.

3. Power supply

Turn-on solar controller, check that PWR LED (green) and RUN LED (red) are on.

Turn-on power supply for string monitors. Go through string monitors, one by one, and check that power LED (green) is steady "on", no blinking or flickering. If not, skip to troubleshooting section.

4. Check communication

Connect NAD manager (or CyBroIexManager) and check that all devices are listed. If not, skip to troubleshooting section.

5. Set communication address

Default address, given by factory, is equal to serial number. Each device should be given a new address, the one which reflect it's position.

By convention, position numbers for string monitors are going from 100 to 119 (or less, if fewer then 20 monitors are used). Position 100 is farthest and 119 is closest to the inverter. Position number 200 is used for inverter (COM-PCS), 201 for indoor temperature sensor (TS-H) and 202 for weather station (COM-WXT). For other (optional) devices, consult tech support.

Use NAD manager to change address from serial number to position number, according to the following table. Repeat procedure for each device, until all addresses are changed.

device	SMB 1	SMB 2	...	SMB 20	COM-PCS	TS-H	COM-WXT
position number	100	101	...	119	200	201	202
old address	9817	9973	...	9912	9517	9914	9288
new address	100	101	...	119	200	201	202

To make the identification easier, when a string monitor is selected, ALERT LED (red color, high-brightness) is flashing.

When finished, check that each address is set properly.

6. Setting parameters

Use SCU touch panel to set working parameters (Settings menu).

section_number	Section in which solar controller belongs (0-no sections, 1-section A, 2-section B, 3-section C...). Used to calculate section totals.
smb_count	Number of string monitors connected to solar controller. Allowed range is 1 to 20. Used to calculate summary data.
pcs_nominal_power	Nominal power of connected inverter in kW. Leave zero if no inverter is connected. Used to calculate percentage of maximum power.
pv_reference_range	Nominal range of photovoltaic reference cell [W/m^2]. When insolation is equal to given value, cell output should be 10.000V. Typical values are 1000 and 1400 W/m^2. Used to calculate insolation.
panel_surface	Total surface of all PV panels connected to solar controller [m^2]. Has to be calculated as number of panels multiplied by total active surface, given by manufacturer. Used to calculate panel efficiency.
energy_price	Buy-out price for one MWh of output energy [euro]. Used to calculate income.
pv_reference_position	Position where PV reference cell is actually connected. Position is given as 0 to 19, corresponding to string monitor position numbers 100 to 119.
ambient_temperature_position	Position where ambient temperature sensor is actually connected. Position is given as 0 to 19, corresponding to string monitor position numbers 100 to 119.
panel_temperature_position	Position where panel temperature sensor is actually connected. Position is given as 0 to 19, corresponding to string monitor position numbers 100 to 119.
temperature_limit	Acceptable string monitor internal temperature [°C]. Used as a limit for over-heating alarm.
difference_enable	Enable difference detection alarm (0-disable, 1-enable). Alarm is reported when corresponding positive and negative currents differ more then specified. Alarm is not active if current output power is lower then 20% of maximum power.
difference_limit	Acceptable difference between positive and negative leg [A].
power_loss_enable	Enable power loss detection alarm (0-disable, 1-enable). Alarm is reported when one string has significantly lower output then others. Alarm is not active if current output power is lower then 20% of maximum power.

power_loss_percent	Percent of average power to detect power loss error [%]. Average power is defined as total power divided by number of strings.
theft_enable	Enable theft detection alarm (0-disable, 1-enable). Alarm is reported if tamper wire is broken. Leave disabled if tamper wire is not connected.
logo_selection	Select which logo to display on solar controller panel (0-Robotina, 1-SanRex).
date/time	Current date and time, displayed in international notation (ISO 8601, yyyy-mm-dd, hh:mm:ss). Time is given in 24-hour format. Local time is used, no daylight saving.

Example:

section number	1	(section A)
number of string monitors	12	(actual number of connected string monitors)
inverter nominal power	250kW	(100, 250 or 500kW)
pv reference range	1000W/m^2	(standard reference for moderate climate zones)
panel surface	2556m^2	(15 x 10 x 12 = 1800 panels, 1800 x 1.42m^2 = 2556m^2)
energy buy-out price	380.02€	(0.38 EUR/kWh)
pv reference position	0	(reference is connected to first string monitor)
ambient temperature position	0	(ambient temperature sensor is connected to first string monitor)
panel temperature position	1	(panel temperature sensor is connected to second string monitor)
temperature limit	60°C	(maximum expected temperature)
difference enable	1	(on)
difference limit	0.5A	(maximum expected imbalance)
power loss enable	1	(on)
power loss percent	75%	(maximum expected difference)
theft enable	0	(off)
logo selection	0	(Robotina logo)

7. Write parameters to EEPROM

To make them permanent, parameters should be written to EEPROM.

To do this, enter write magic as 31415, then set write request. When parameters are written, both write magic and write request will reset to zero.

To check if parameters are written correctly, change one parameter (e.g. select another logo), then set read request. When reading is finished, parameter will return to correct value. Check also that all other parameters are set correctly.

8. System errors

Use SCU panel to check for errors: open Controller and go one page down. In case of an error, go back to step 4.

9. Internet connection

To check Internet connection, open Info page and press Send push button.

If connection is established, display will show roundtrip time in milliseconds.

If connection is not established, roundtrip time will keep running for about 10 seconds, then reset to -1.

5.3. Troubleshooting

String monitor is not communicating

1. Use digital multimeter to check that power supply is 18..26V. PWR LED should be steady on.

2. Check communication wiring. When properly connected, IEX2 LED should be blinking.

3. Check for duplicate communication address.

4. Replace string monitor.

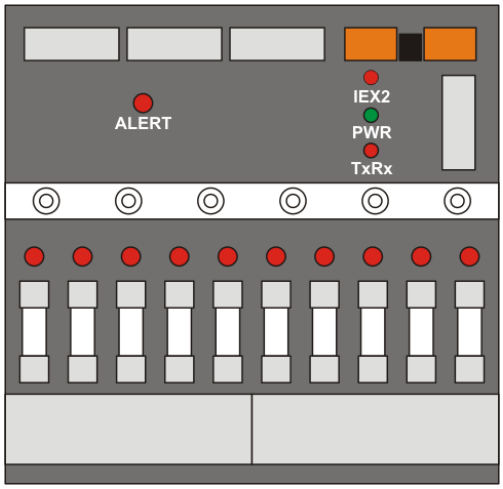
Two devices have same communication address

1. Disconnect power supply from one of devices.

2. Change communication address of other device.

3. Connect power supply and check that conflict is gone.

String monitor indicators



PWR on - power supply ok
off - no power supply
blinking - internal error or faulty power supply

IEX2 blinking - communication ok
on - no communication, faulty wiring
off - no communication

TxRx blinking - slave board ok
on/off - slave board error

FUSE off - fuse ok
blinking - fuse blown (only when string voltage is present)

ALERT blinking - device selected by NAD manager

COM-PCS indicators

PWR on - power supply ok (CAN bus side)
off - no power supply (CAN bus side)
blinking - internal error or faulty power supply

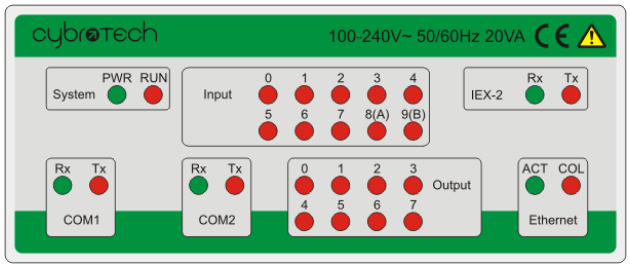
IEX2 blinking - communication ok
on - no communication, faulty wiring
off - no communication

+5V on - power supply ok (inverter side)
off - no power supply (inverter side)

Tx blinking - transmitting to inverter ok
off - no communication to inverter

Rx blinking - receiving from inverter ok
off - no communication from inverter

Solar controller indicators



PWR on - power supply ok
off - no power supply
blinking - internal error or faulty power supply

RUN on - program ok
off - program stopped, check run/stop switch
blinking - program error

COM2 Tx/Rx blinking - touch panel ok
Tx blinking, Rx off - touch panel not connected
Tx/Rx off - internal or configuration error

IEX-2 Tx/Rx blinking - communication to string monitors ok
Tx/Rx on - communication error, one or more wires not connected
Tx blinking, Rx off - error, shortcut between communication lines
Tx/Rx off - internal or configuration error

ETH ACT blinking - ethernet ok
COL blinking - colisions detected
ACT off - not connected or no traffic

5.4. String monitor procedures

Connecting NAD Manager

NAD Manager may be connected anywhere on the CAN communication bus. Find the most appropriate place and connect. Four wires are used, two for 24V power supply, and two for communication.

1. Use communication adapter to connect directly to solar controller.

2. Connect to bus on either side of power supply unit.

3. Open string monitor transparent lid, and connect to RJ9 connector on the left board (the one with orange connectors).

Using NAD Manager

1. Connect NAD Manager.

2. Wait until software initialization is done (approximately 30 seconds).

3. Use ▲ and ▼ buttons to select device, then press ✓ button.

4. Use ▲ and ▼ buttons to set new communication address, then press ✓ button.

Repeat steps 3 and 4 as many times as needed.

When string monitor is selected, it's internal "Alert" LED is blinking red. High brightness LED is used, so it should be visible from a distance, even during daylight. That may be used to identify devices mounted on inaccessable locations.

Replacing broken string monitor

1. Replace broken string monitor with a new one.

2. Connect strings, power and communication lines.

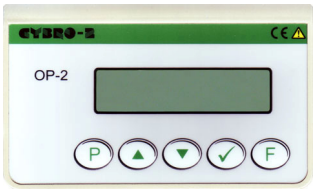
3. Change communication address to match the replaced unit.

Methods for managing communication address

Three ways to change CAN communication address exist. They are all equally good, method may be selected according to preferences.

1. NAD Manager (hardware)

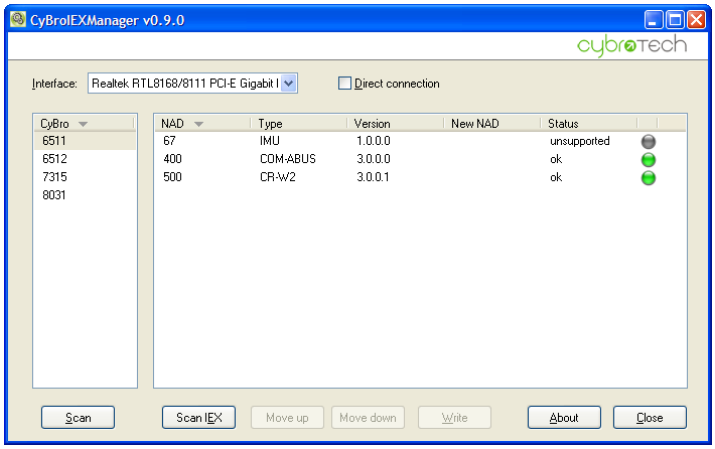
NAD Manager (Network Address Manager) is a small, hand-held device used to set communication addresses.



Back side has RJ-9 (4P4C) female connector, used for 24V power supply and communication. Use the enclosed adapter to connect NAD manager directly to solar controller, string monitor, or to the nearest bus connection.

2. CyBro IEX Manager (PC software)

CyBro IEX Manager is software for setting communication address. It is connected to solar controller using Ethernet connection.



Basic function is the same as NAD Manager. It is a recommended method for a large power plant.

3. CyBro IEX Loader (PC software)

IEX loader is tool to update firmware on CAN devices, but it can also be used to update communication address. It connects to bus using USB-to-PCAN adapter, or tunneling through solar controller.

IEX loader is a backup solution - it may be used when both hardware and software NAD manager are not applicable.

5.5. Solar controller procedures

Configuring IP address

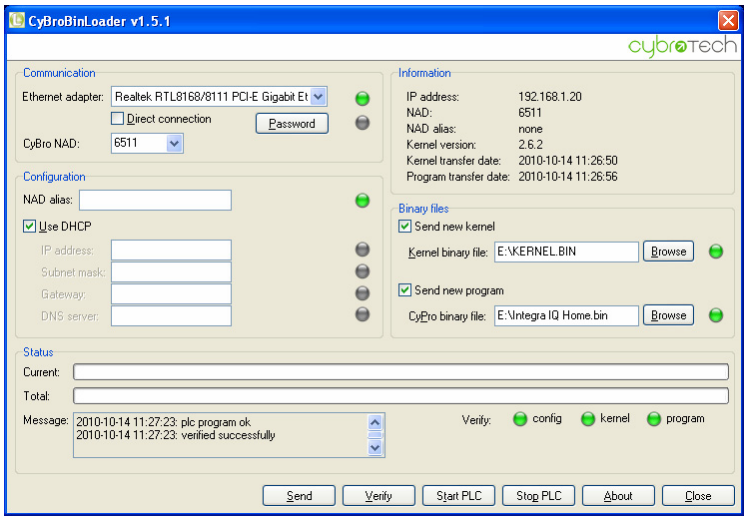
Solar controller by default use DHCP server to obtain IP address. This is a preferable method. If DHCP server is not available, static IP address may be assigned.

If need known IP address for each controller is needed, use DHCP server with static allocation (also known as "IP reservation" or "Static DHCP").

Configuring static IP address

To assign static IP address, open CyBroBinLoader tool:

1. Select network adapter
2. Use CyBro NAD drop-down list to select controller
3. Uncheck Use DHCP checkbox
4. Enter IP address, subnet mask, gateway and DNS server
5. Press Send button



If controller is not recognized, you may use direct connection. Connect PC directly to solar controller, one-to-one, no switches or routers in between.

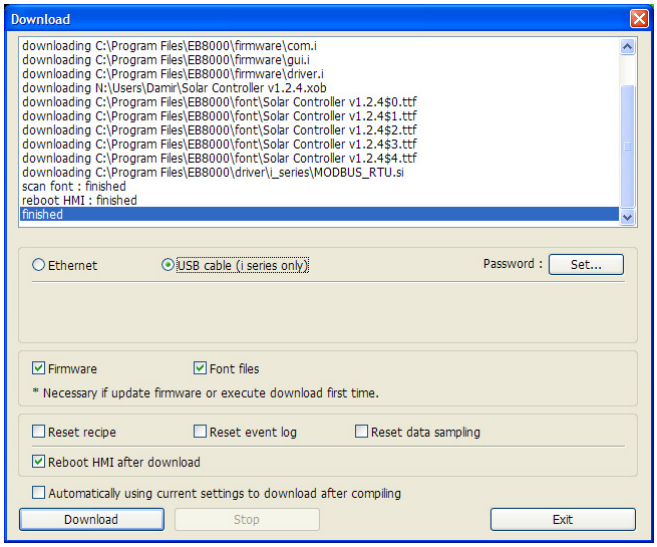
When connected, PC may need a few minutes to set autoconfigured IP address. To verify that address is assigned, check system tray.

When address is ready, start CyBroBinLoader, check Direct connection, and continue same way as if network connection is used.

Updating solar controller software

1. Use CyBroBinLoader and ethernet connection to send kernel and plc program to device.

2. Use EasyBuilder8000 and USB cable to send touch panel software.



3. Set configuration parameters.

Replacing broken solar controller

1. Replace solar controller (alternatively, replace only broken component: CyBro, power supply or touch panel).

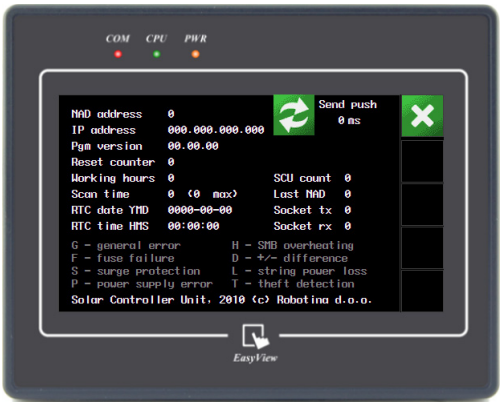
2. Set configuration parameters.

3. Solar Mini, edit configuration file, replace old NAD with a new one.

4. Solar Web, page and data logger configuration, replace old NAD with a new one.

Setting-up Internet connection

To check Internet connection, press "Send push" button.



When connection is established, round-trip time from controller to server is displayed. Typical values are 50-200ms for wired connection, 200-400ms for 3G connection, and 500-1000ms for GPRS/EDGE.

If connection is not established, after a few seconds -1 will appear.

Note: UDP port 8442 on router/firewall should be open for both sending and receiving.

Setting parameters

1. Setup using touch panel

- open settings screen
- press parameter button

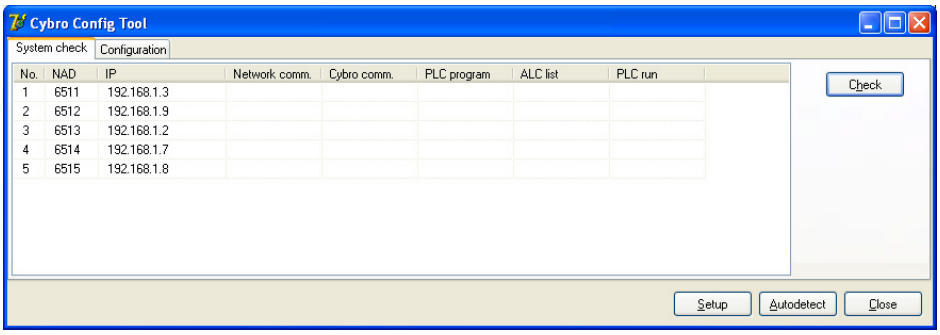
- enter a new value and press ENT

If wrong digit is entered, press BS (backspace) to clear last digit, or ES (escape) to ignore whole input.

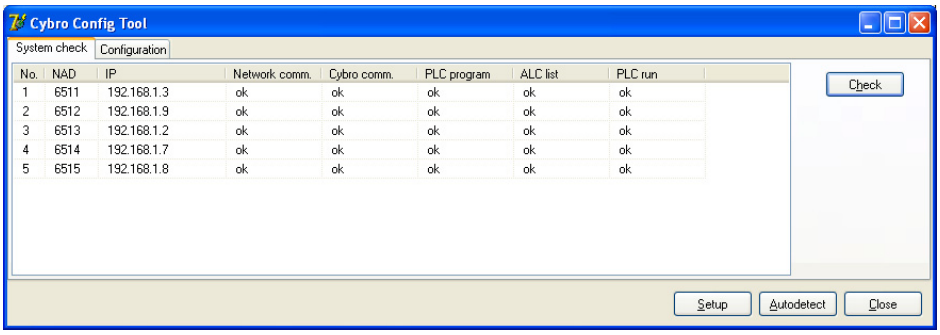
2. Setup using CyBroConfigTool

This method may be used when solar controllers are connected in local network. All controllers are set at once.

- start CyBroConfigTool
- open Setup, select network adapter and connection type
- press Autodetect button - list of solar controllers will appear

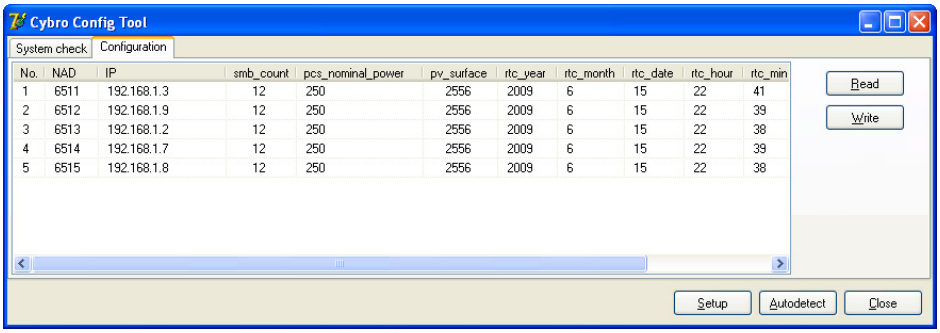


- press Check button - all fields should be "ok"


Cybro Config Tool
System check
Configuration
No. NAD IP Network comm. Cybro comm. PLC program ALC list PLC run
1 6511 192.168.1.3 ok ok ok ok ok
2 6512 192.168.1.9 ok ok ok ok ok
3 6513 192.168.1.2 ok ok ok ok ok
4 6514 192.168.1.7 ok ok ok ok ok
5 6515 192.168.1.8 ok ok ok ok ok
Check
Setup
Autodetect
Close

- switch to Configuration tab
- enter parameters

- press Write button

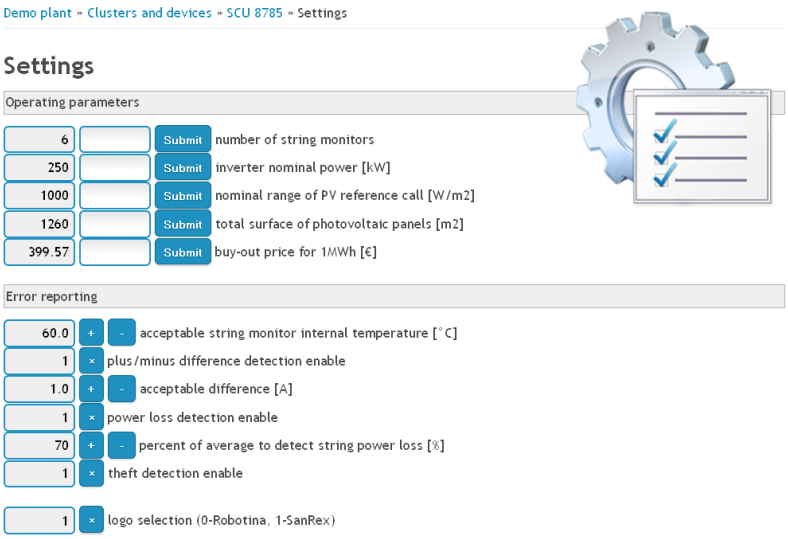


After writing, program automatically read values back, to verify that data is written correctly.

3. Setup using Solar Web

This method may be used if plant is already connected to Internet, or local Solar Web server is installed. Access credentials (username and password) with "write tags" permission are needed.

- open www.solar-cybro.com
- log on using your username and password
- open plant settings page
- set parameters


Demo plant » Clusters and devices » SCU 8785 » Settings
Settings
Operating parameters
6 Submit number of string monitors
250 Submit inverter nominal power [kW]
1000 Submit nominal range of PV reference call [W/m2]
1260 Submit total surface of photovoltaic panels [m2]
399.57 Submit buy-out price for 1MWh [€]
Error reporting
60.0 acceptable string monitor internal temperature [°C]
1 plus/minus difference detection enable
1.0 acceptable difference [A]
1 power loss detection enable
70 percent of average to detect string power loss [%]
1 theft detection enable
1 logo selection (0-Robotina, 1-SanRex)

Take care that parameters are written to EE memory.

6. Maintenance

There is very little to replace during a product lifetime, components are selected to provide lifetime of 25 years or more. However, local regulations, and manufacturer recomendations for electrical installations ought to be respected.

On regular basis we suggest the following:

Daily maintenance

SPSS contineously monitors relevant working parameters. Measurements are summarized in main status signal:

no errors, system is working fine
error encountered

Maintenance employee is expected to check status daily. In case of an error, he finds the cause and immediately take measures to correct the problem. Prolonged response may result with damage of equipment and decreased yield.

If system is connected to Internet, daily maintenance may be performed remotely.

If system is equiped with SMS alarm system (option GSM1), daily maintenance is not required, therefore status checking may be performed weekly. If system is set to automaticaly send reports, status checking may be performed monthly.

Yearly maintenance

Detailed visual inspection is expected each year, starting from the third year after installation. Plastic cover shall be removed and visual inspection carried out. Based on result, the following actions should be taken:

- in presence of dust or stains (liquid), transparent cover with seal should be replaced
- if traces of condensed water are detected, pressure equilizer element should be replaced
- all screws in power circuit should be checked and, if needed, tightened to the specified torque

We suggest IR camera inspection to detect possible hot spots. If hot spot is detected, screw should be tightened, and inspected again.

In a specially tough conditions (high average temperature, presence of sea water, salt or thin dust), more often inspection or even systematic replacement may be indicated.

Spare parts

Spare parts are available from Robotina and distributors, while consumables are available from Robotina, distributors and specializied resellers.

Fuses	There is no need to systematically replace fuses as a part of maintenance procedure. However, plant designer may decide preventive replacement to increase better availability of the plant. Preventive replacement may reduce heat loss and increase product lifetime.
Surge protection	Surge protection devices (SPD) are monitored through auxilary contacts by SMB. They need no special manitenance, only replacement if SPD is broken.
Disconnector switch	In normal operating conditions, disconnector switch requires no special maintenance. However, humidity or air pollution may oxidize contacts and increase pole resistance, resulting in excess heat dissipation.

Maintenance cost

Altrough only a few parts are sistematically replaced, there is a chance that some elements fail in period of 25 years.

Estimated cost of replacement parts (without consumables like fuses, SPD replacement modules) is 5% of SPSS price. Since no actual data is available yet, estimate is based on artificial aging and statistics.

7. Technical Data

7.1. String Monitor Box

Input

DC voltage	1000V max.
Measurement	0..1100V range, ±1.5% accuracy, 2s period
DC current for each string	10A nominal, 12A max.
Current measurement	0..12A range, ±1.5% accuracy, 2s period
Power loss for each string	1.2W typ. (1mΩ clamp + 7mΩ fuse + 2mΩ shunt + 2mΩ track = 12mΩ)
Connection	cage clamps + cable glands (default) faston/MC3/MC4/custom connectors (option)
Cable cross section	1.5..16mm^2 (16..6 AWG)
Overvoltage protection	SPD 1kV (4kV max.), protection level type 2
Fuse	yes, each input

Output

DC voltage	1000V max.
DC current	100A @ 55°C, 110A @ 45°C max. (plastic) 90A @ 55°C, 110A @ 45°C max. (stainless steel)
Connection	cable glands + 120mm^2 stud terminals, M10 nuts, 10-20Nm torque
Cable cross section	120mm^2 max.
Disconnector switch	ABB SACE, TMAX PV T1D-160 (option)

Communication Cable

Type	2 x 2.5mm^2 twisted pair (24V power supply) 2 x 0.5mm^2 shielded twisted pair (CAN/IEX-2 communication)
Length	500m max. (check also "Connecting" section)
Connection	cable glands + 2x4 pole cage clamps, orange, PCB mounted, 2.5mm^2 connectors (one for incoming and one for outgoing cable), shield grounded
Termination	internal, 120ohm on last device (manually activated by mini-switch)

Control Circuit

Supply	24V (18..26V)
Power consumption	50mA typ. (24V, P+N version, relay 4x off, LED off) 120mA max. (24V, P+N version, relay 4x on, LED on)
Withstanding voltage	5kV AC RMS 50Hz 3 seconds 8kV 1.2us/50us pulse
Lacquer finish	15kV/mm
Creepage distance	10mm
Clearance	9.6mm
PCB flammability rating	UL94-V0
Communication	IEX-2/CAN, 20/50/100/250/500kbps, autoselectable
Fuse control status	yes, 25V typ. failure detection level
Overvoltage protection status	yes
Internal temp. measurement	yes, -50..+100°C, ±0.5°C accuracy
External temp. measurement	yes, -50..+100°C, ±0.5°C accuracy, digital sensor, cable length up to 20m
Photovoltaic reference cell	yes, 0..10V for 0..1000W/m^2, ±0.5% accuracy, 24V power supply
Anti-theft protection	yes, close-circuit tamper wire
General-purpose inputs	4 analog/digital inputs, 0..10V or contact (internal pull-up 12V/2mA)
General-purpose outputs	4 relay outputs 3A/250V

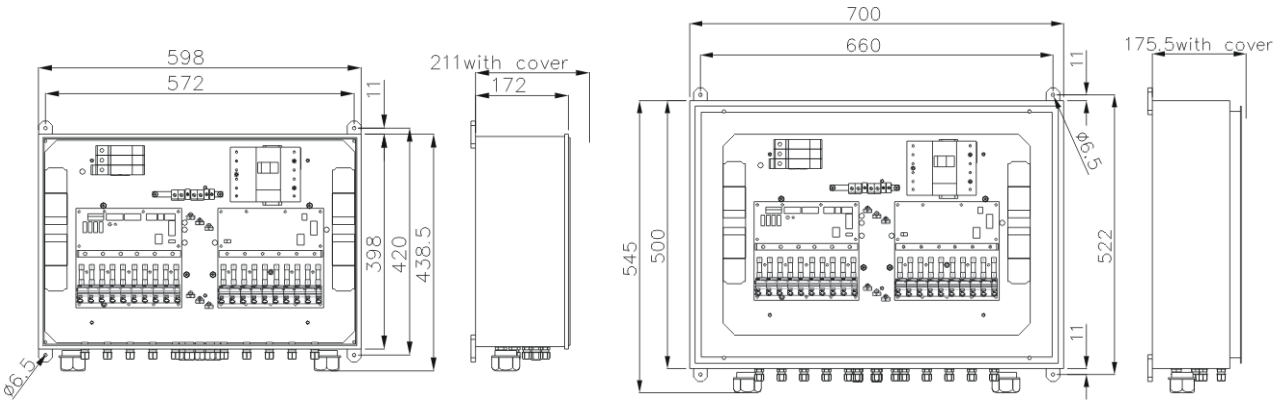
Mechanical & Environmental

Installation	outdoors, shaded area
Material, base & clear lid	polycarbonate
Electrical insulation	totally insulated
Flammability rating	UL94-5V
Glow wire test	960°C, halogen free
UV resistance	UL 508
Vibration test	10..57Hz/0.075mm, 57..150Hz/1G, XYZ, 10 sweeps per axis
Impact resistance	IK 08
Ingress protection	IP 65
Grey parts color	RAL 7035
Transparent clear cover	smoked grey
Ambient temperature	-25..+55°C (-13..130°F)
Thermal resistance	0.35K/W
Relative humidity	0..95% non-condensing
Dimensions	598 x 398 x 211mm (23.5" x 15.7" x 8.3") (plastic) 700 x 500 x 170mm (27.5" x 19.6" x 6.7") (stainless steel)
Weight	11kg (plastic) 21kg (stainless steel)
Package	725 x 570 x 245mm (plastic)

Standards

LVD	EN 50178
EMC	EN 61000-6-2, EN 61000-6-4
CE	yes

Dimensions



plastic

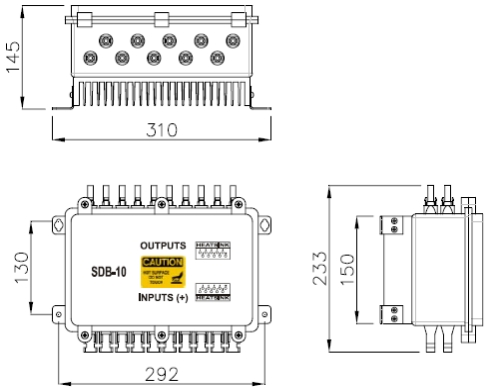
stainless steel

7.2. String Diode Box

Input & output

Number of inputs	10
Input connection	faston/MC3/MC4/custom connectors (option)
Number of outputs	10
Output connection	faston/MC3/MC4/custom connectors (option)
Number of diodes	10
Forward current for each string	20A max.
Voltage drop	1.2V @ 10A
Reverse voltage	1600V max.

Dimensions



7.3. DC Combiner Box

Input

Number of inputs	2..20
Number of fuses	2 x number of inputs
Voltage	1000V max. (fuse to 125A), 900V max. (fuse 160A)
Current (each input)	100A max. (fuse rating: 1,5 x Isc)
Connection	ring-lug, hole 8mm
Cable cross section	120mm^2 max.

Output

Number of output cables	2..10 (5 positive, 5 negative)
Connection	ring-lug, hole 12mm
Cable cross section	120mm^2 max.

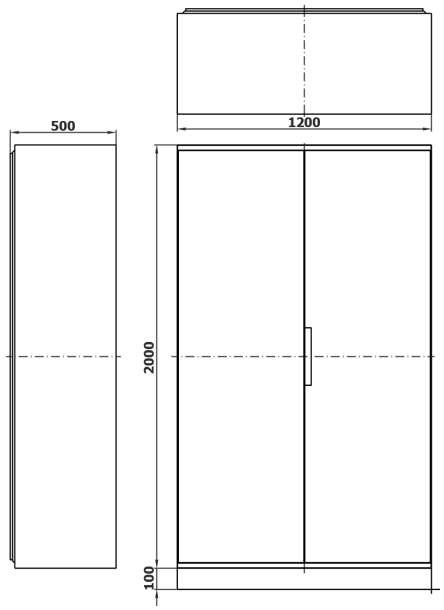
Control Circuit

Supply	24V (18..26V)
Power consumption	120mA typ.
Monitoring	switch disconnectors and overvoltage protection

Mechanical & Environmental

Dimensions	1200 x 2000 x 500mm (WxHxD) (DCB-20, for other types consult factory)
Weight	cca. 300kg (DCB-20)

Dimensions



7.4. Solar Controller Unit

Power supply

Nominal input voltage	230Vac or 115Vac, manualy selectable
Allowed voltage range	176..264V or 85..132V
Frequency	47..63Hz
Input current	0.7A max. or 1.3A max.

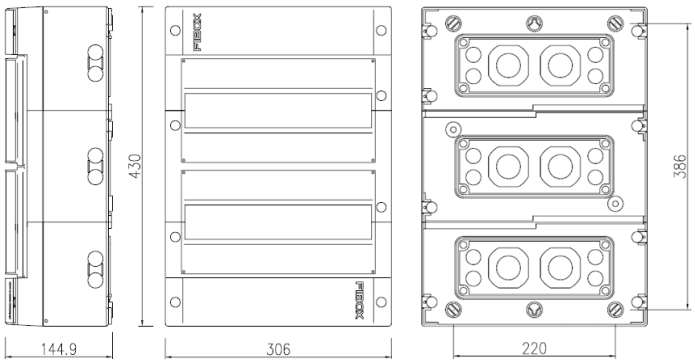
Control Circuit

Monitor boxes per controller	20 max.
Communication	IEX-2/CAN
Baudrate	20/50/100/250/500kbps, software-defined
Ethernet connection	10/100BASE-T, cable autodetect
IP address	DHCP (default) or static (on request)

Mechanical

Installation	indoor
Material, base & clear lid	polycarbonate
Electrical insulation	totally insulated
Flammability rating	UL94-5V
UV resistance	UL 508
Impact resistance	IK 08
Transparent clear cover	smoked grey
Ingress protection	IP 20
Ambient temperature	0..+45°C
Relative humidity	0..95% non-condensing
Dimensions	430 x 306 x 145mm
Weight	4.2kg

Dimensions



7.5. Power Supply Unit

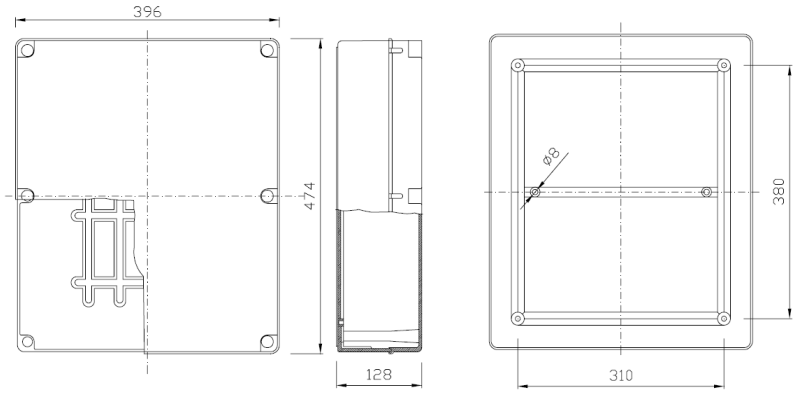
Input

Nominal input voltage	230Vac or 115Vac, manualy selectable
Allowed voltage range	176..264V or 85..132V
Frequency	47..63Hz
Input current	1.2A max. or 2.2A max.

Output

Maximum load	20 string monitors

Dimensions



8. Appendix

8.1. Available signals

String monitor

smb00_current_p0..9	Positive side measured current in 0.1A units (e.g. 82 means 8.2A).
smb00_current_n0..9	Negative side measured current in 0.1A units (e.g. -82 means -8.2A).
smb00_voltage	Measured output voltage (V).
smb00_pv_reference	Photovoltaic reference cell measurement (W/m2).
smb00_fuse_error_p0..9	Positive side fuse error.
smb00_fuse_error_n0..9	Negative side fuse error.
smb00_fuse_error	Common fuse error, logical OR of all positive and negative fuses.
smb00_surge_error	Surge protection error.
smb00_general_error	One or more system errors occured (timeout, program or hardware error).
smb00_timeout_error	Communication failed, no messages are coming from the module.
smb00_program_error	Internal or configuration error detected, module is not functional.
smb00_hardware_error	Module detected hardware (measurement_status) or communication error.
smb00_iex_power_supply	Measured power supply voltage in 0.1V units (e.g. 242 means 24.2V).
smb00_measurement_status	Measurement status: 0-measurement ok, 1-master board error, 2-slave board error. If slave board is not present, no error is indicated.
smb00_slave_board_status	Status of slave pcb board (0-present, 1-missing).
smb00_temperature_0	Measured internal temperature, multiplied by 10 (e.g. 247 means 24.7°C).
smb00_temperature_1	Measured external temperature, multiplied by 10 (e.g. 247 means 24.7°C).
smb00_sensor_error_0	Temperature sensor 0 (internal) is not working properly.
smb00_sensor_error_1	Temperature sensor 1 (external) is not working properly.
smb00_ix00..03	Binary input (0-open, 1-closed).
smb00_iw00..03	Analog input 0, potentiometer or voltage 0..10V (0..1023).
smb00_qx00..03	Relay output (0-open, 1-closed).
smb00_alert_led	LED for visual module identification (0-off, 1-on).

Inverter

pcs00_ac_voltage	Measured output AC voltage, in 0.1V units, range 0..420V.
pcs00_ac_current	Measured output AC current, in 0.1A units, range 0..137.4A (100kW), 0..343.6A (250kW) or 0..687.3A (500kW).
pcs00_ac_power	Current output AC power, in 0.1kW units, range -10..100kW (100kW), -25..250kW (250kW) or -50..500kW (500kW).
pcs00_frequency	Measured output frequency, in 0.1Hz units, range 0..100Hz.
pcs00_dc_voltage	Measured input DC voltage, in 0.1V units, range 0..500V.
pcs00_dc_current	Measured input DC current, in 0.1A units, range 0..200A (100kW), 0..500A (250kW) or 0..1000A (500kW).
pcs00_integral_power_lo	Total integral power, low word, in 0.1kWh units (100kW/250kW inverter) or 0.05kWh units (500kW inverter).
pcs00_integral_power_hi	Total integral power, high word.
pcs00_integral_power_today	Total integral power for today, in 0.1kWh units.
pcs00_ac_current_total	Measured total output AC current, in 0.1A units.
pcs00_ac_power_total	Calculated total output AC power, in 0.1kW units.
pcs00_dc_current_total	Measured total input DC current, in 0.1A units.
pcs00_temperature	Temperature measured inside inverter, in 0.1°C units, range -50..50°C.
pcs00_solar_radiation	Amount of solar radiation, in W/m2 units.
pcs00_device_status	Inverter status, b0:com error, b1:operation sw off, b2:operation grid, b3:operation independent, b4:unused, b5:standby, b6:stop, b7:PCS breakdown, b8:grid abnormality, b9:waiting manual reset.

pcs00_damage_status_0 ..... Inverter damage status 0, b0:ACOVR, b1:ACUVR, b2:OFR, b3:UFR, b4:ISO passive, b5:ISO active, b6: ACOVR moment, b7:ACUVR moment, b8:phase rotation fail, b9:OVGR, b10:sync fail, b11:ACOCR, b12:DCOVR, b13:DCUVR, b14:DCOCR, b15:DCUPR.

pcs00_damage_status_1 ..... Inverter damage status 1, b0:RPR, b1:DCGR, b2:MCB trip, b3:fuse melting, b4:temperature abnormal, b5:ACOCR hard, b6: ACOVR monitoring, b7:DCOCR hard, b8:ACOVR independent, b9:ACUVR independent, b10:ACOCR independent, b11:voltage suppression, b12:voltage suppression limit, b13:ACUVR AUX, b14:MC state abnormal, b15:communication error.

pcs00_current_date ..... Current inverter date, b0-b4:date (1..31), b5-b8:month (1..12), b9-b15:year-1980 (0..127).

pcs00_current_time ..... Current inverter time, b0-b4:seconds/2 (0..29), b5-b10:minutes (0..59), b11-b15:hours (0..23).

pcs00_damage_history_date..... Damage history date stamp, b0-b4:date (1..31), b5-b8:month (1..12), b9-b15:year-1980 (0..127).

pcs00_damage_history_time..... Damage history time stamp, b0-b4:seconds/2 (0..29), b5-b10:minutes (0..59), b11-b15:hours (0..23).

pcs00_damage_history_event_0..... Damage event, 1st/2nd (high/low byte), 01-ACOVR protection, 02-ACUVR protection, 03-OFR, 04-UFR, 05-ISO passive, 06-ISO active, 07-ACOVR moment, 08-ACUVR moment, 09-phase rotation fail, 10-OVGR, 11-sync fail, 12-ACOCR, 13-DCOVR, 14-DCUVR, 15-DCOCR, 16-DCUPR, 17-RPR, 18-DCGR, 19-MCB trip, 20-fuse melting, 21-temperature abnormal, 22-ACOCR hard, 23-ACOVR monitoring, 24-DCOCR hard, 25-ACOVR independent, 26-ACUVR independent, 27-ACOCR independent, 28-voltage suppression, 29-voltage suppression limit, 30-ACUVR AUX, 31-MC state abnormal, 32-communication error.

pcs00_damage_history_event_1..... Damage event, 3rd/4th byte.

pcs00_damage_history_event_2..... Damage event, 5th/6th byte..

pcs00_damage_history_event_3..... Damage event, 7th/8th byte.

pcs00_damage_history_number ..... Damage history index, range 0..15. Allows access to one of 16 damage logs stored in inverter. Number 0 is latest, number 15 oldest.

pcs00_damage_history_read_req ..... Request to read a single damage history event from inverter. Usage: clear damage_history_date, set damage_history_number, set request, wait until damage_history_date is set, then read result.

pcs00_damage_history_clear_req..... Request to clear inverter damage history. Set write_enable to 1 before sending request. After sending, reset write_enable to prevent data corruption.

pcs00_write_enable..... Reset for normal operation, set to allow writing to inverter.

pcs00_set_date ..... Set inverter date, b0-b4:date (1..31), b5-b8:month (1..12), b9-b15:year-1980 (0..127).

pcs00_set_time ..... Set inverter time, b0-b4:seconds/2 (0..29), b5-b10:minutes (0..59), b11-b15:hours (0..23).

pcs00_set_datetime_req ..... Request to set new date and time. Usage: enter set_date and set_time, set write_enable, then set request bit. After sending, reset write_enable to prevent corruption.

pcs00_general_error ..... One or more system errors occured (timeout, program or bus error).

pcs00_timeout_error..... Communication failed, no messages are coming from the module.

pcs00_program_error..... Internal or configuration error detected, module is not functional.

pcs00_bus_error..... Module detected a number of communication errors, but it is still working.

pcs00_com_error..... Communication with inverter is broken.

pcs00_iex_power_supply ..... Measured power supply voltage, in 0.1V units, range is 0..30V.

pcs_dc_power ..... Inverter input power [0.1kW].

pcs_ac_power ..... Inverter output power [0.1kW].

pcs_ac_power_ratio ..... Inverter output power in percents [0.1%].

pcs_efficiency..... Inverter efficiency, ac_power/dc_power [%].

pcs_integral_power ..... Total output energy measured and integrated by inverter [0.1kWh].

pcs_integral_power_today..... Total output energy for present day [0.1kWh].

pcs_co2_reduction ..... Total CO2 reduction [kg].

pcs_money_earned..... Total money earned by power production [eurocents].

pcs_general_error ..... Combined inverter general errors.

pcs_com_error..... Combined inverter com errors.

pcs_status_total ..... Combined device status errors (0-ok, 1-error):
  w_device_status_b0 ..... com error
  w_device_status_b1 ..... operation sw off
  w_device_status_b2 ..... operation grid
  w_device_status_b3 ..... operation independent
  w_device_status_b4 ..... (unused)
  w_device_status_b5 ..... standby
  w_device_status_b6 ..... stop
  w_device_status_b7 ..... PCS breakdown
  w_device_status_b8 ..... grid abnormality
  w_device_status_b9 ..... waiting manual reset
pcs_damage_total ..... Combined inverter damage errors (0-ok, 1-damage).
pcs_combined_error ..... Combined error status for all inverter(s) (0-ok, 1-error).

pcs_ac_power_max ..... Maximum output power ever [0.1kW].
pcs_ac_power_max_today ..... Maximum output power today [0.1kW].
pcs_ac_power_per_min[0..59] ..... Total output power sampled per minute, last 60 minutes [0.1%].
pcs_ac_power_per_hour[0..47] ..... Total output power sampled per hour, last 48 hours [0.1%].
pcs_integral_power_per_date[0..31] ..... Output energy per day, date 1..31 is index [0.1kWh].
pcs_integral_power_per_month[0..12] ..... Output energy per month, month 1..12 is index [0.1kWh].

Solar controller

version_major ..... Version of plc program, major byte.
version_minor ..... Version of plc program, minor byte.

reset_counter ..... Counts number of resets.
operating_hours ..... Total operating hours from first start [h].

push_req ..... Set to send push message and start timer.
push_roundtrip ..... Time from sending push message to receiving acknowledge [ms].

smb_count ..... Number of string monitor boxes in system (0..20).
pcs_nominal_power ..... Nominal power of inverter [kW].
panel_surface ..... Total surface of all photovoltaic panels [m2].
energy_price ..... Buy-out price for 1MWh of output energy [eurocent].
temperature_limit ..... Acceptable smb internal temperature [0.1°C].
difference_enable ..... Enable difference detection alarm (0-disable, 1-enable).
difference_limit ..... Acceptable positive/negative current difference [0.1A].
power_loss_enable ..... Enable power loss detection alarm (0-disable, 1-enable).
power_loss_percent ..... Percent of string average power to detect power loss error [%].
theft_enable ..... Enable theft detection alarm (0-disable, 1-enable).

simulation_enable ..... Enable simulation of smb and inverter measurements.
accelerated_time ..... Speed-up rtc time, to see accelerated simulation.
simulate_fuse_error ..... Simulate fuse failure (0-disable, 1-enable).
simulate_surge_error ..... Simulate surge protection failure (0-disable, 1-enable).
simulate_power_supply_error ..... Simulate low power supply voltage (0-disable, 1-enable).
simulate_overheating_error ..... Simulate string monitor internal overheating (0-disable, 1-enable).
simulate_difference_error ..... Simulate positive/negative current imbalance (0-disable, 1-enable).
simulate_power_loss_error ..... Simulate string power loss (0-disable, 1-enable).
simulate_theft_detection ..... Simulate theft detection (0-disable, 1-enable).
simulate_inverter_trip ..... Simulate inverter failure (0-disable, 1-enable).

smb_voltage ..... Common DC voltage of string array, derived from smb measurements [V].
smb_current[0..19] ..... Sum of positive string currents for each smb [0.1A].
smb_current_total ..... Total sum of all string currents [0.1A].
smb_power[0..19] ..... Power per string monitor, voltage*current [0.1kW].
smb_power_total ..... Total string power, measured by string monitors [0.1kW].
smb_string_count[0..19] ..... Number of active strings detected on a given string monitor (0..10).
smb_string_count_total ..... Total number of detected active strings.

smb_general_error_total ..... Combined general error of all configured strings.
smb_fuse_error_total ..... Combined fuse error of all configured strings.
smb_surge_error_total ..... Combined surge protection error of all configured strings.
smb_power_supply_error[0..19] ..... String monitor 24V power supply is out of limits.
smb_power_supply_error_total ..... Combined power supply errors.
smb_overheating_error[0..19] ..... Internal string monitor temperature is too high.
smb_overheating_error_total ..... Combined overheating errors.

smb_difference_error[0..19]..... At least one string has positive/negative current imbalance.
smb_difference_error_total..... Combined current difference errors.
smb_power_loss_error[0..19] ..... String monitor power output is too low, a string is possibly broken.
smb_power_loss_error_total ..... Combined power loss signal.
smb_theft_detection_total ..... Combined theft detection signal.
smb_combined_error..... Combined error status for all string monitors (0-ok, 1-error).

insolation ..... Current sun power measured by reference cell [W/m2].
panel_efficiency..... Efficiency of photovoltaic panels [%].

combined_error ..... Combined error status for whole plant (0-ok, 1-error).

The list is for informative purposes only. For a real production scada or modbus gateway, ask for latest alc/csv files. These files are automatically generated for each software revision, so they always reflect actual state.

8.2. Status tree

Supervisory system provides status signals related to string monitors, inverter, and the plant as a whole. Signals are combined tree-like, ending with combined_error signal. If combined_error is off, the whole plant is working properly.

combined_error

- smb_combined_error
  - smb_general_error_total
    - smb00_general_error
      - smb00_timeout_error
      - smb00_program_error
      - smb00_hardware_error
        - smb00_measurement_status
    - smb01_general_error
    - ...
    - smb19_general_error
  - smb_fuse_error_total
    - smb00_fuse_error
      - smb00_fuse_error_p0
      - smb00_fuse_error_n0
      - smb00_fuse_error_p1
      - smb00_fuse_error_n1
      - ...
      - smb00_fuse_error_p9
      - smb00_fuse_error_n9
    - smb01_fuse_error
    - ...
    - smb19_fuse_error
  - smb_surge_error_total
    - smb00_surge_error
    - smb01_surge_error
    - ...
    - smb19_surge_error
  - smb_power_supply_error_total
    - smb_power_supply_error[0]
    - smb_power_supply_error[1]
    - ...
    - smb_power_supply_error[19]
  - smb_overheating_error_total & temperature_limit
    - smb_overheating_error[0]
    - smb_overheating_error[1]
    - ...
    - smb_overheating_error[19]
  - smb_difference_error_total & difference_limit & difference_enable
    - smb_difference_error[0]
    - smb_difference_error[1]
    - ...
    - smb_difference_error[19]
  - smb_power_loss_error_total & power_loss_percent & power_loss_enable
    - smb_power_loss_error[0]
    - smb_power_loss_error[1]
    - ...
    - smb_power_loss_error[19]
  - smb_theft_detection_total & theft_enable
    - smb_theft_detection[0]
    - smb_theft_detection[1]
    - ...
    - smb_theft_detection[19]

pcs_combined_error

- pcs_general_error
  - pcs00_general_error
    - pcs00_timeout_error
    - pcs00_program_error
    - pcs00_bus_error
- pcs_com_error
  - pcs00_com_error
- pcs_status_total
- pcs_damage_total

8.3. Touch panel screens